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ABSTRACT

This paper recounts observations of differences in the interactions of adult students when they are engaged in traditional worksheet tasks in contrast to small group activities and summarizes recent research on the benefits of group work in adult mathematics learning. It offers a selection of group and pair activities designed to foster discussion, encourage visualization and estimation, and facilitate a sense of mathematical meaning beyond formulae and symbol manipulation. (The asymmetry of power and knowledge is less defined in group and pair tasks than in worksheet situations because in the latter situations interactions result in explanatory speech, while in the former they result in exploratory speech. In addition to collaborative structures changing the quality of student interactions, they also expand the range of interactive roles with students spontaneously taking on roles that both increase their means of actively contributing to discussions and signal their participation. In adult classes, educators often focus on the individual needs of students that can be met with traditional worksheet tasks, but small group activities fulfill social needs that can establish cultural touchstones and position students in roles of equality. By connecting sense and symbols, group and pair activities can encourage students to make meaningful connections that strengthen and broaden their understanding of mathematics.) The document includes 14 references.

Connecting Students, Sense, and Symbols: A Workshop of Practical Activities From Personal Experience, and Informed by Research

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Connecting Students

A great deal has been said about the benefits of group work in mathematics learning. Indeed, I have found it a wonderful way to conduct major sections of all my adult classes, both in basic education and pre-service teacher education. In my own classrooms, and in those I have observed through research, I have found many positive benefits from students working together on a variety of structured group problems. The comments which follow are drawn from recent research (Marr, 2000, see elsewhere in this volume) in which I observed the differences in student interactions when engaged in traditional worksheet tasks, in contrast to small group activities.

Collaborative Structures Change Quality of Student Interactions

I found that explicit group and pair structures tended to change the quality of students' interaction and collaboration from that which occurred when using worksheets. In traditional interactions resulting from worksheets, one student tended to wait until another had worked out an answer alone before requesting help, and then was likely to receive more fully thought out opinions or procedures, "explanatory speech" (Barnes, 1976). It seemed that collaborative structures encouraged students to share thoughts whilst they were still in the formative stages, "exploratory speech" (Barnes, 1976). This exploratory interaction style put the students on a more equal footing in the early stages of engagement with the task, and tended to change the power dynamics. Evidence of "intersubjective" meaning making (Cobb, 1995) or jointly constructed knowledge (Mercer, 1995) was found in excerpts of students' dialogue. For example, interrogative phrases like "that's what you are saying aren't you?" and "is that what you mean?" indicated that the students were clarifying ideas together and building on each other's explanations. Thus it seemed that the asymmetry of power and knowledge was less defined in group and pair tasks than it was in worksheet situations.

Group Collaboration Expands the Range of Interactive Roles

Group collaboration also tended to expand the range of interactive roles students could take on, thereby increasing their means of actively contributing to discussion and signaling their participation. Some took on social roles within the group: explaining the task to latecomers, keeping the group on track, and asking clarifying questions. Others contributed differing types of knowledge. For example, some contributed knowledge drawn from their use of measurement at home, social discourses (Lee, 1994), exemplified by contributions about cups and cubic metres of soil. Others contributed from their knowledge of the mathematical discourses such as fractions and areas. These roles were not assigned, or even discussed, in this classroom, but occurred spontaneously during the group work. Their existence was noted only after analysing tapes and videos of the group interaction. The emergence of these different roles within the task interaction allowed more students to contribute positively to the group and to learn from others whilst doing so.

The notion of contributing and learning as a peripheral participant (Rogoff, 1995) was illustrated by one student who took on a social facilitation role in the small group. This role allowed her a way to participate actively although she had little confidence in her knowledge of the topic. In doing so she signalled her involvement and learned from the discussion of the other group members. These multiple roles in the small groups appeared to allow for diversity of participation, in contrast to the situation of "primary knowers" and those who asked for their help (Veel, 1999), which predominated in worksheet situations.

Catering for Individuals Versus Social Needs

However, adult classes are often made up of students with a wide range of needs, and levels of knowledge. This tends to mean that educators are swayed towards providing individual work that satisfies the expressed needs of each student, and deciding that working in groups will not be appropriate. Although I agree that catering for

each individual student is essential in most adult situations, I also think it is important to consider making connections within the groups as well.

I believe that for many adult students there is an unspoken social need that is integral to their return to study. Leaving the isolation of the home and mixing with others seems an important part of the new learning experience. In my experience the need for this aspect of returning to study is especially true of adult women students. If their classes are organised to include some time in which students mix with each other in structured group and/or pair activities then they have opportunities to create the necessary social links. Mixing purposefully with other students allows for the creation of personal connections through sharing information about one another. Beach (1992), referring to this type of interaction between students as "self disclosure about their lives and experiences" (p. 99), asserts that in some circumstances the social bonds created make students more willing to listen to each other's subject related ideas. So not only does such conversation create possibilities of social communication and friendship but it also creates links which facilitate students helping each other with the subject.

My own teaching experiences with adults indicate that group activities, which foster discussion through hands-on activity, can change students' attitude to the subject and make the classroom atmosphere lively, cooperative, and enjoyable. In the classroom research I found that not only did sharing the materials bring students together to solve problems, the materials were often a trigger for other forms of communication. For example, sharing memories of childhood games was provoked by the string used for area and perimeter investigations, and the plumbing pipes fitted together to model a cubic metre facilitated recollections of building cubby-houses and many jokes about children. These connections with childhood pursuits could be seen as negative distractions if they continued for too long. However, this was not usually the case, and it is also possible to view these off-task moments from the perspective suggested by Baynham (1996). Baynham refers to "identity work": interchanges between the adult class members and the teacher that enabled them to see themselves in equal adult roles outside of the classroom situation. Baynham sees this identity work as an important aspect of students maintaining their self-respect and adult status in the potentially disempowering classroom situation. Similarly, Benn (1999) refers to establishing "cultural touchstones," a range of common interests between teacher and students, which are referred to in classroom communication and act to bridge cultural and status gaps. Thus sharing stories of common childhood experiences or "positioning" the students in the parent role (Walkerdine, 1988) can be seen as a valuable dimension of the class. In this case it was facilitated by hands-on materials.

Household containers and bottles used in several activities also seemed to provoke a sharing that "positioned" the students in the adult world. For example, alcohol bottles, ice cream, and yoghurt containers encouraged exchanges about drinking habits and food preferences. These off task exchanges, triggered by the introduction of real world artefacts into the classroom, allowed for the personal disclosure, identity work, and creation of cultural touchstones described above.

Connecting Sense and Symbols

The examples discussed illustrate valuable connections between people, the teacher and students, that can be facilitated by group and pair work using reality based situations and artefacts. If, in addition, the group and pair activities are selected to encourage students to make meaningful connections between their lives, mental images, and the symbols and formulae of mathematics, then the time is doubly well spent.

In the research classroom real-life materials such as the domestic containers seemed to contribute positively to the mathematical dimensions of the tasks for these adults. The data revealed the domestic artefacts acting as "footholds" from familiar discourses into the mathematical activity (Boomer, 1986). Or, put another way, the students could "position" themselves in a field where their prior knowledge or conceptual frameworks were connected with the current mathematical meanings. For example, their practical knowledge of familiar containers assisted estimating unfamiliar volumes. The deceptive visual impact of tall thin cylinders was "noticed" because it resonated with students' adult consumer awareness. This not only allowed for discussion of packaging strategies, but also for formulating hypotheses about shape and volume relationships. It also created

continuous opportunity to develop students' mathematical language. These were positive illustrations of linking "spontaneous" and "scientific" concepts (Bruner, 1984; Vygotsky, 1962).

Yet another unexpected effect of using the familiar domestic and other hands-on materials was the triggering of memories from one session to the other which seemed to be created through the visual impact of the physical artefacts. The lasting memories appeared stronger than any that the words and diagrams traditionally used on worksheets had provoked, since students' speech in later tasks contained many direct references back to prior visual memories. Their hold on the mathematical ideas and relationships seemed to be strengthened by association with previous instances in which they had arisen. For example, the food and drink containers used in the estimation task became synonymous with cylinders and were visualised by the students in later tasks. The string used to model "fencing," or perimeter, was also referred to in later situations.

Students who made connections between the tasks seemed to be showing evidence of greater "ownership" of the relationships and the language. These observations agree with suggestions by Brown, Collins, and Duguid (1989) that exposure to conceptual language in a variety of different situations strengthens and broadens students' understanding of mathematical terms.

This workshop offered a selection of group and pair activities designed to foster discussion, encourage visualisation and estimation, and facilitate a sense of mathematical meaning beyond formulae and symbol manipulation.

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